(12) UK Patent Application (19) GB (11) 2 029 677 A

(21) Application No 7833554
(22) Date of filing 16 Aug 1978
(23) Claims filed 8 Aug 1979
(43) Application published
19 Mar 1980
(51) INT CL³
H05B 3/06
(52) Domestic classification
H5H 140 191 223 224 231
233 250 258 274 275 AX
H2H HR7
(56) Documents cited
None
(58) Field of search
H2H
H5H
(71) Applicants
Exeter International
Finance Corporation,
c/o Arias,
Fabrega & Fabrega,
Apartado 6307,
Panama 5 R.E.P.
(72) Inventors
Graham Eric Midworth
(74) Agents
Kilburn & Strode

(54) **Fluid warmer**

(57) A heater for blood plasma flowing through a flexible tube comprises a block (12), having elongate passages (11) in one face into which the tube can be pressed to be in intimate heat exchange relationship with the block, a plurality of resistance heaters 13 embedded in the block and connected to different connector pins 14 of a multiple male connector (15), and a plurality of different assemblies each consisting of a multisocket female connector (27), a lead (28), and a connector (29) adapted for connection to a different standard power supply. The sockets of female connectors (27) on the different assemblies are interconnected in different ways so that the heaters (13) are connected in different ways (series, series/parallel or parallel) in accordance with the particular power supply being used.

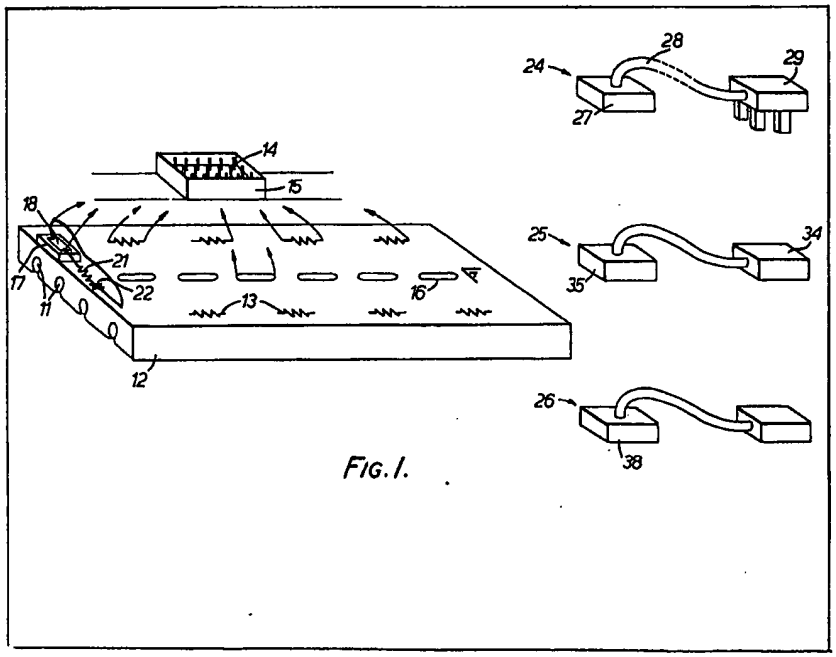

FIG. 1.

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

GB 2 029 677 A

2029677

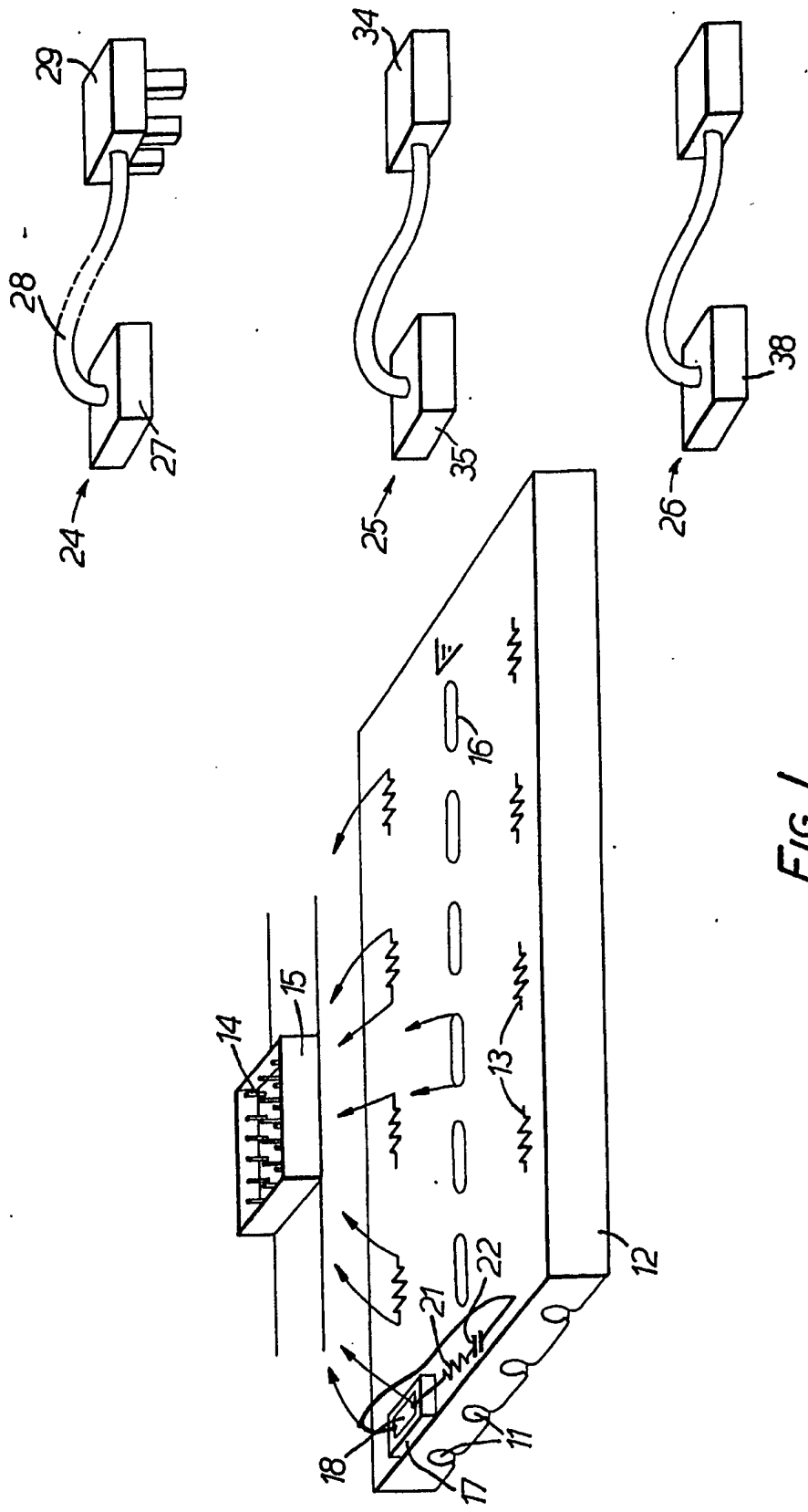

FIG. 1.

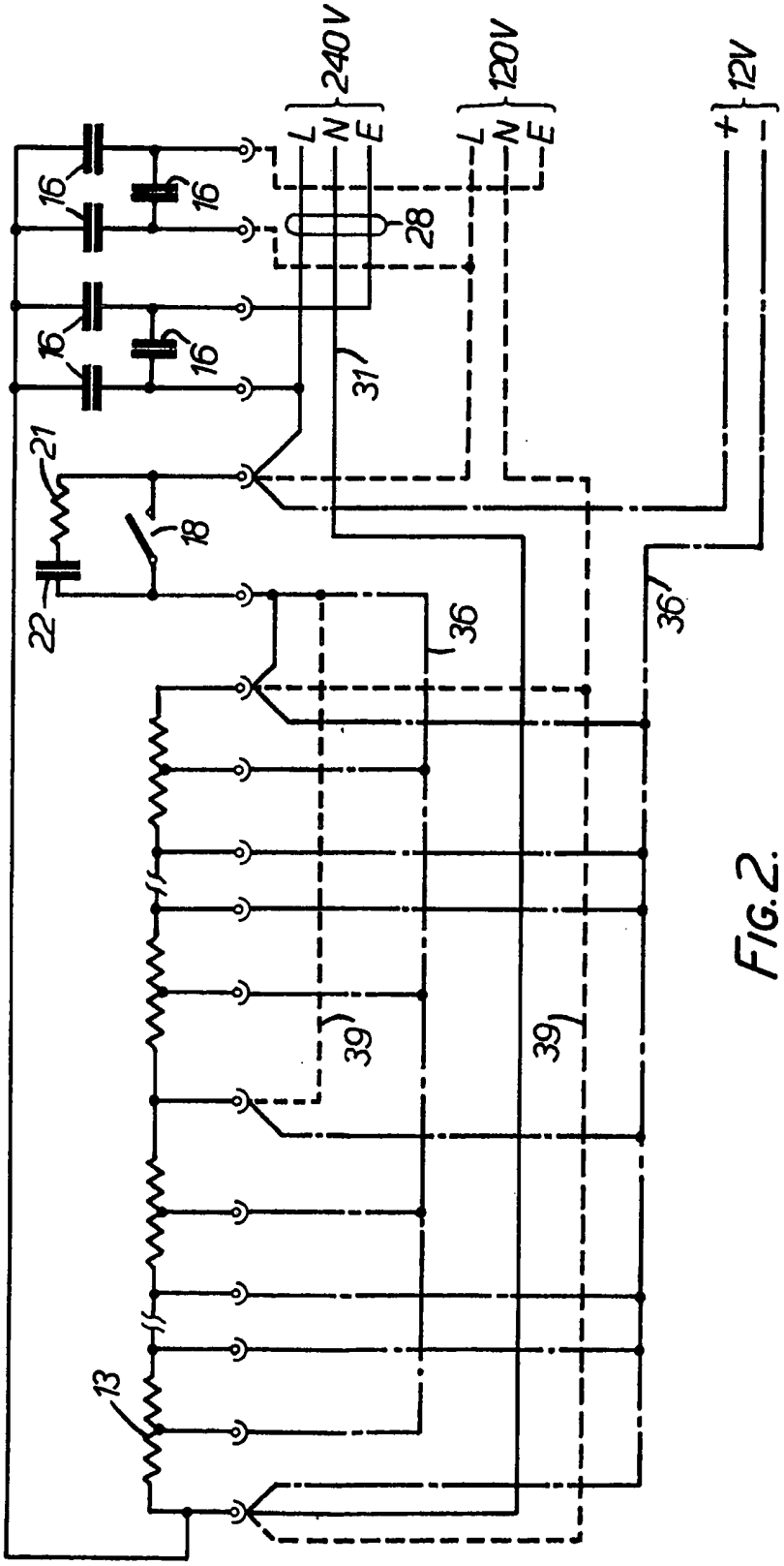

FIG.2

SPECIFICATION

Fluid warmer

This invention relates to a heater for a fluid flowing through a flexible tube for example blood plasma or saline solution for infusing into the blood system of an animal requiring treatment.

Although it is known to preheat blood plasma for a human being under treatment in hospital, so far it has not been practical to do the same thing for animals under treatment by a Vet, because of the very wide range of different types of blood needed by the various animals requiring treatment. It has however been discovered that an animal can often be kept alive while an operation is performed, for example, by supplying heated saline solution into its blood stream. The temperature of the solution is not very critical provided it is within a few degress of the nominal temperature of the animal's blood, but it is necessary to provide quite substantial rates of flow of up to perhaps 3 or 4 litres per hour. The temperature should be at 40°C or a little below that, which in many cases will require a 15°C rise above ambient temperature in the heater.

An object of the invention is to provide a design of heater enabling those requirements to be fulfilled even in some of the difficult circumstances encountered by a Vet.

According to the present invention, a heater for fluid flowing through a flexible tube comprises a block of thermally conductive material, which the tube can be brought into close contact with, an electrical heater for the block comprising a number of electrical resistance elements, connected to different connections of a multiple connection socket, and two or more plugs having connections complementary to those of the socket, each of the plugs having a different arrangement of interconnection of the complementary connectors in relation to input terminals to the plug.

The arrangement has the advantage that whatever power supply is available, the heater can still be used provided the appropriate plug is chosen.

Thus for use in a surgery where the 240 volts a.c. mains are available, a plug can have interconnections arranged to connect all the heater elements in series across the input to the plug. Thus, if say there are 20 elements, each rates at 12 volts, then if the 240 volts a.c. supply were available, a plug could be used with interconnections such as to connect the 20 heater elements each rated at 12 volts in series across the supply, whereas if say, only a 12 volts car battery was available, perhaps from the Vet's car during an emergency operation in a field, a plug could be used which connected the heater element in parallel across the battery, so that once again each element would receive its 12 volts.

Preferably, each plug is permanently connected to its own lead, designed for plugging in at the end remote from the plug into say the a.c. mains, or onto the terminals of a battery.

Preferably there will be a thermostat responsive to the temperature of the block where the tube leaves it, and it has been discovered that many theremostats only open and close their contacts sharply when the contacts are carrying the full rates current. Now the full rated current will be 20 times higher if a 12 volts battery is being used, than if the 240 volts mains are being used, and if the thermostat is designed to carry the higher current, it has been found that the thermostat does not always operate sharply if it is only carrying the 20th value of current when the a.c. mains are being used.

However, it has been found possible to improve the operation of the thermostat by connecting an R.C. circuit in series across the thermostat contacts, and/or to connect a network of capacitors across the line, earth and neutral terminals of the a.c. supply, preferably with equal capacitors between line and earth, and earth and neutral, and with a much larger capacitor between line and neutral.

In a preferred arrangement the electrical resistance heater elements are embedded at different parts in the block of conducting material, which itself has one or more straight grooves extending along one face of such a section that the flexible tube carrying the fluid can be pressed into the groove without having to have access to either end, and will then be in intimate heat exchange relationship with the block. If there are a number of grooves extending along the block parallel with each other, then the tube can be passed to and fro up and down those grooves, so that as much of the length of the tube as is desired is in such intimate heat contact with the block.

The tube may have a manually operated device for controlling the rate of flow of fluid through a tube, in dependence on the rate at which the fluid is to be supplied to the animal. Then it may be found desirable to have a great length of the tube in contact with the block for greater rates of flow, so that the temperature can be controlled quickly.

The invention may be carried into practice in various ways, and one embodiment will now described by way of example with reference to the accompanying drawings in which:

Figure 1 is a sketch of a heater in accordance with the invention; and

Figure 2 is a circuit diagram of the heater of Figure 1.

The heater comprises a extruded metal block having a number of grooves 11 extending parallel with one another along the length of one face of the block, so that a flexible tube carrying a saline solution to be heated can be pressed into the grooves to be in intimate heat contact with the metal of the block 12. Four grooves 11 are shown, and one or more can be used in accordance with the amount of heat to be imparted to the fluid. If all four grooves are to be used, the tube can be pressed into one groove, curved round and pressed into another and so on.

The block 12 is arranged to be heated by a number of electrical resistant heaters 13 embedded in the material of the block and distributed around its surface. In a preferred form of the invention there are ten heaters each designed for 24 volts, and they are centre tapped so that each half comprises a 12 volt heater. In the interest of clarity only eight of the half

heater elements are shown. They are connected in a series chain, and each points of the chain is connected to one of an array of connector pins 14 in a male connector 15 mounted on the casing of the heater.

A thermostat 17 has switch contacts 18 which are connected to a further pair of connector pins. The thermostat has a heat sensitive element in intimate heat conducting relationship with the body 12 adjacent the place where the flexible pipe will leave the body after being heated. The thermostat contacts 18 are shunted by a series resistor 21, and capacitor 22.

Two groups of three capacitors 16 are also mounted on the block. The capacitors of each group are connected in delta, and one point of each delta is connected to one of the chain of heaters 13, while the other two points of each delta are connected to the appropriate one of two further pairs of connector pins.

In fact, the thermostat 17 has two sets of switch contacts which operate at different temperatures; the appropriate set is selected by a switch according to the amount of heating of the fluid which is required. In the interests of simplicity, these components are not shown in the drawing. There is also a lamp for indicating when the mains supply is connected to the heaters, and a pair of lamps of different colours for indicating when the heater elements 13 are energised; one lamp of the pair is operative, depending on which set of thermostat contacts is in use. These lamps are also omitted from the drawing.

There are three alternative connectors 24, 25 and 26, any one of which can be used in dependence on the type of electrical supply available for energising the heaters 13.

Each connector includes a female connector 27 adapted to engage with a male connector 15, and having contacts complementary to the pins 14. There is a flexible lead 28 leading from the connector 27 to a plug 29 or other connection for connection into a mains socket or onto the terminals of a battery, or to some other source of supply that may be available.

The conductors in the lead 28 and the complementary contacts in the connector 27 are interconnected in a different way in each of the units 24, 25, and 26, so that the heater 13 will be interconnected to suit the supply voltage that is available.

Figure 2 shows the circuit diagram of the heaters 13 and the connectors, and again in the interest of clarity only 8 of the half heater elements are shown, although it will be obvious how the other 12 heater elements are connected.

The connector 27 in the unit 24 which has 240 volts a.c. mains plug 29 has internal connections corresponding to the solid lines 31 in Figure 2, and it can be seen from that figure that when the connector 27 is engaged with the connector 15, the heater elements 13 are electrically connected in series with the thermostat contacts 18 between the line and neutral conductor leads 28. One of the groups of capacitors 16 is connected in delta across the various pairs of line neutral and earth conductors 28. In the example described there is a .005μF capacitor between the line and earth conductors and between the earth and neutral conductors and a .1μF capacitor between the line and neutral conductors.

When the unit is used, the mains voltage will be divided equally between all the heaters so that each receives its rated voltage.

That would be suitable for use in a surgery where the mains supply was available, but if a Vet wanted to use the heater on a farm where the only supply was his car battery, he would use the unit 25 having a connector 34 adapted for connection across his car battery, and a connector 35 for mating with the connector 15, the connections to which are as shown in the chain dotted line in Figure 2 at 36.

Examination of Figure 2 shows that when the unit 25 is used, the heaters 13 are connected in parallel across the d.c. supply, so that once again each receives its rates 12 volts.

If a 120 volts a.c. supply were available, as is frequently the case in U.S.A., then the third unit 26 would be used with a connector 38 which has internal connections between the co-operating pins in accordance with the dashed lines 39 of Figure 2. With that arrangement the heaters are in two series sets, the two sets being connected in parallel across the supply so that once again each receives its rates 12 volts. In that arrangement the other group of capacitors 16 is connected across the line, neutral and earth connections. The effect of the capacitors 16 is to provide de-coupling between the mains conductors, which in conjunction with the capacitor and resistor 22 and 21 connected across the thermostat contacts, tend to assist the thermostat to operate quickly when the set temperature is achieved, whatever method of interconnection of the heaters with the supply conductors is being used. In the example being described, the resistor 21 is 100 ohms and the capacitor 22 is .1μF.

If it were found possible to use the same three capacitors 16 for both 240 volt and 120 volt operation, the line point of the delta could be connected directly to the line side of the thermostat 17, while only a single connector pin 14 would be needed to provide the earth connection to the third point of the delta.

85 watt heaters have been found in one example to enable fluid flowing at up to 4 litres per hour to be heated through 15°C which is ample for most veterinary applications.

CLAIMS

1. A heater for fluid flowing through a flexible tube comprising a block of thermally conductive material with which the tube can be brought into close contact, an electrical heater for the block comprising a number of electrical resistance elements connected to different connections of a multiple connection socket (or plug), and two or more plugs (or sockets) having connections complementary to those of the socket, (or plug) each of the plugs (or sockets) have a different arrangement of interconnection of the complementary in relation to input terminals of the plug (or socket),

2. A heater as claimed in Claim 1 in which one plug (or socket) has interconnections arranged to connect all the heater elements in series across the input to the plug (or socket).

3. A heater as claimed in either of the preceding claims in which one plug (or socket) has interconnections arranged to connect the heater elements in parallel across the input to the plug (or socket).

4. A heater as claimed in any of the preceding claims in which each plug (or socket) is permanently connected to its own lead, designed for plugging in at the end remote from the plug (or socket) into a particular electrical supply.

5. A heater as claimed in any of the preceding claims, including a thermostat responsive to the temperature of the block where the tube leaves it.

6. A heater as claimed in Claim 5 including an R.C. circuit in series across the thermostat contacts.

7. A heater as claimed in Claim 5 or Claim 6 including a network of capacitors connected across the line, earth and neutral terminals of the A.C. supply.

8. A heater as claimed in Claim 7 in which there are equal capacitors between line and earth and between earth and neutral, and a much larger capacitor between line and neutral.

9. A heater as claimed in any of the preceding claims in which the electrical resistance heater elements are embedded at different parts in the block conducting material.

10. A heater as claimed in any of the preceding claims in which the block of conducting material has one or more straight grooves extending along one face with a cross section such that a circular flexible tube can be pressed into the groove without it being necessary to have access to either end of the tube, and the tube will then be in intimate heat exchange relationship with the block.

11. A heater as claimed in any of the preceding claims including a device for controlling the rate of flow of the fluid through a tube.

12. A heater for fluid flowing through a flexible tube constructed and arranged substantially as herein specifically described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office by Croydon Printing Company Limited, Croydon Surrey, 1980.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.